COMPRESSION LEAKS

CLOVER INSTRUCTIONAL BULLETINS

No. 75 and No. 80

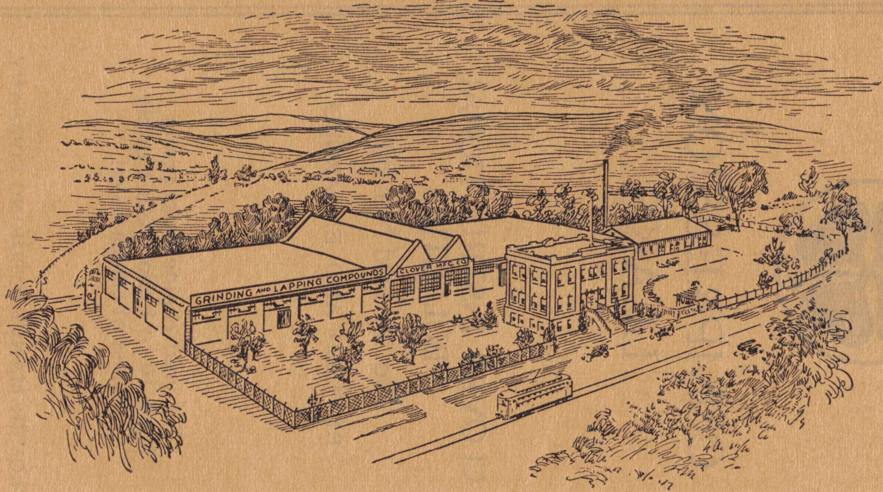
REVISED AND ENLARGED

"If your engine lacks power it's a 10 to 1 shot your trouble is loss of compression"

CLOVER MANUFACTURING COMPANY
Norwalk, Conn.

Chicago — San Francisco
Los Angeles — Seattle

4th Edition



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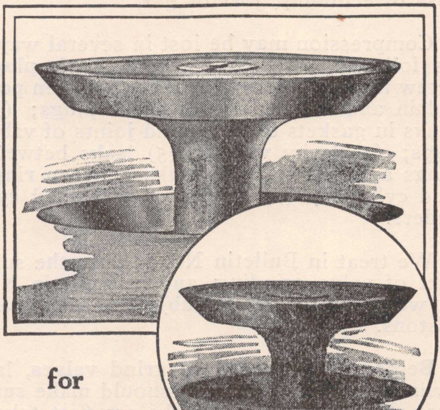
The Clover Mfg. Co. Plant at Norwalk, Conn.

Compression Leaks

Bulletin No. 75

VALVE GRINDING



for

Automobiles

Tractors

Marine Engines

Stationary, Gas and Oil Engines and Air Compressors

TREATING the matter broadly, our purpose in grinding valves in a hydrocarbon engine is to insure an absolutely tight cylinder, to the end that the compression of gases may be always maintained, as the power of the engine is in direct proportion to the compression, and loss of compression means loss of power, loss of economy, loss of gas.

Compression may be lost in several ways, as follows: (1) leaks where spark plugs screw into cylinders; (2) leaks between porcelain and metal parts of spark plugs; (3) leaks in gaskets or in ground joints of valve caps; (4) leaky valves; (5) leaks between rings and pistons; (6) leaks between rings and cylinder; (7) scored or scratched cylinders.

We treat in Bulletin No. 75 only the subject of valve grinding, and in Bulletin No. 80 we cover the entire subject of leaks past pistons.

Before you proceed to grind valves, lap cylinders or fit rings, you should make sure that all other possible leaks are first taken care of as described later. **Fig. 5.**

Much has been written about valve grinding, but it is surprising how little **accurate** knowledge is available about this simple though highly important operation. Remember that the power of your engine is in direct proportion to its compression. Leaky valves means loss of power.

Our purpose in this bulletin is to give in non-technical language a minute description of the process of valve grinding, so that anyone interested can grind a valve and do a first-class job.

May we also venture the suggestion that many mechanics might find much of interest to them in this bulletin.

There is a right and a wrong way of doing every job, and we will try to tell you the **right way,** proceeding step by step throughout the operation, and giving you all the little kinks, so highly important.

Removing the Spring. The first thing we must do is to remove the valve spring which keeps the valve down on its seat.

Before proceeding further, let us examine the three most common types of spring seats and keys employed to attach the spring to the valve stem. **Fig. 1** is probably the most generally seen, in which a slot (A) is cut through the valve stem, and a key (B) is inserted after the spring seat (C) has first been slipped onto the stem. The spring seat (C) fits down over, and rests on the key (B), preventing the key from coming out; the valve spring (D), bearing down on the spring seat and keeping it in place.

In **Fig. 2** we have the next most popular type, where a pin is employed instead of a key; **Fig. 3** is still a different type with slots

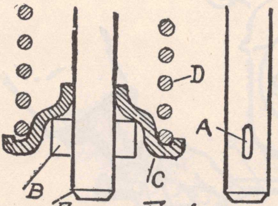


FIG. 1

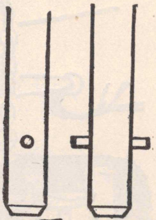


FIG. 2

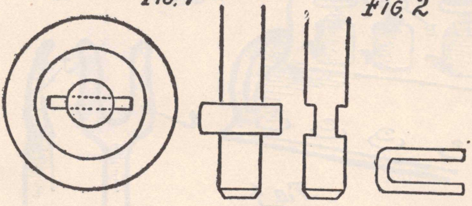


FIG. 3

cut on either side of the valve stem and a small steel U-shaped key that slips into these slots, astride the valve stem.

In all constructions, however, there is some form of key, held in place by a spring seat which comes down over the key as shown, to keep it in place.

To remove the spring, therefore, it is necessary to push the spring seat (C) up on the valve stem until it clears the key, then slip the key out of place.

Now we must go back a step. Before attempting to remove the spring—(1) take a fine file and remove any burr which may have formed on the end of the valve stem at (E), **Fig. 1**, due to service, as sometimes

such burrs prevent the valve stem passing freely through the hole in the spring seat, thus causing annoyance. (2) Remove the cap on the cylinder head over the valve, **Fig. 5,** (C), or in case of an engine with a detachable cylinder head, take the head off first.

Then turn the engine over until the valve is down on its seat, and the push rod which lifts it is clear of it. Then, by use of a special tool shown in **Fig. 4** pry up the valve seat against the pressure of the spring until it clears the key (B), which you remove,

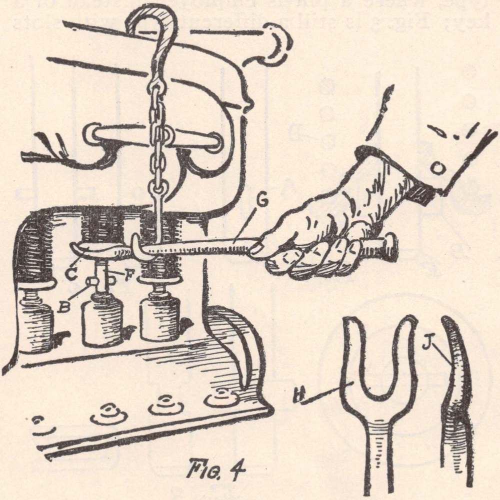


Fig. 4

holding down the valve from above if necessary.

You must hold the spring seat tightly up as shown in **Fig. 4,** until you have pushed the valve stem (F) up through the cylinder head, or clear of the spring seat. Then gently let the spring down, and pull it clear out of place, which is easily done by swinging the tool (G) out towards you while the spring is still resting on it.

The valve spring tool (G), which we show, is one of many, all answering the same purpose, but some working a little easier than others.

The business end of this tool is forked shaped as shown at (H), and if it has a slightly curved surface as shown at (J), it is not as apt to slip out of place as if it were flat.

Valve Stems are Delicate. Caution — You must keep your mind fixed on the fact that valve stems are **very delicate** and bend with the slightest side pressure. Do not allow the valve tool or the spring to bear sideways against the valve stem or you will have a bent stem which it is almost impossible to straighten without special tools.

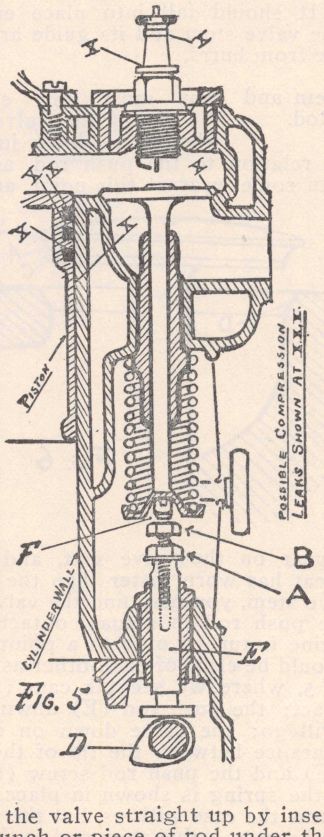


FIG. 5

Push the valve straight up by inserting a small punch or piece of rod under the valve stem in its guide, until you can get hold of it from above, then carefully remove it.

Should the valve stem, due to gumming, stick in its guide, use the greatest care in order to prevent bending the stem.

As soon as the valve is removed, take a little coarse (Grade D) Clover Grinding Compound on a rag or piece of waste, and

polish the valve stem by rubbing it up and down rapidly until the stem is bright. Then take a small piece of waste or cloth, dip it in kerosene, or gasoline, and push it through the valve stem guide several times by using a piece of stiff wire—this is to clean out the guide which is usually gummed up with dried oil and carbon.

Next take the valve and let it drop in place. It should fall into place easily if both the valve stem and its guide are clean and free from burrs.

The Stem and Push Rod. You must now examine the tip of the valve stem, when it is down in place, and its relation to the push rod, as there has been some wear at this point, and also

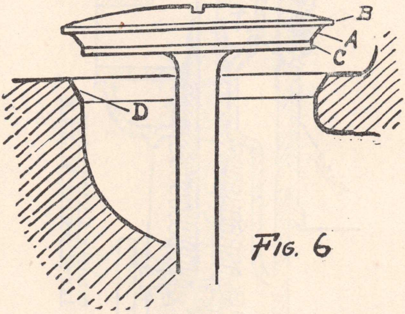


FIG. 6

some wear on the valve seat, and if the valve seat has worn faster than the end of the valve stem, you may find the valve stem and the push rod in actual contact, when the engine is turned over to a point where they should be clear of each other as shown in **Fig. 5**, where we see the cam (D) out of contact; the push rod (E) down as far as it will go; the valve down on its seat and clearance between the tip of the valve stem (F) and the push rod screw (B). In **Fig. 5**, the spring is shown in place, which is not now the case with us, but the **desired** relation between valve stem and push rod is clearly shown.

In the case of some of the smaller engines like the Ford, there is no adjustment provided on the push rod, so you must look sharply for wear at this point in such motors.

Being assured that your valve is resting on its seat, and that the valve stem is clear

of the push rod, we now remove the valve once more and examine its seat.

Ordinarily the valve and its seat are not

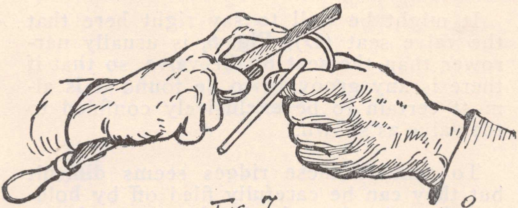


FIG 7

in such bad shape. The valve may leak badly and lose compression, but in reality there is not a great deal to do to it outside of grinding it back to a tight seat. On the other hand, we sometimes run into a very old or abused engine which supplies us with a "horrible example," so we shall mention them here, though we do not often meet them.

If the seat of the valve is free from carbon and looks to be true, though it may be pitted somewhat and scaly, it will probably

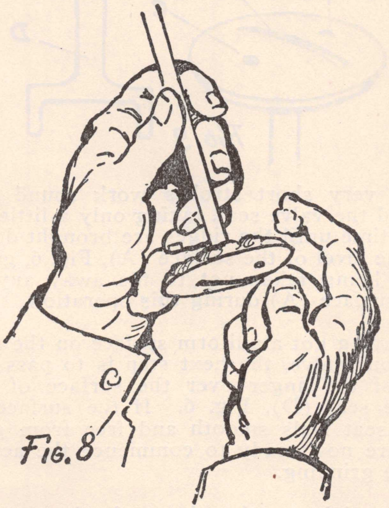


FIG. 8

answer to grinding at once without further attention.

Should, however, the seat be worn in a groove as shown, greatly exaggerated, in **Fig. 6,** seating on the surface (A), with

ridges (B) and (C) on either side of the seat, it is manifest that we must remove these ridges before we can commence to grind the valve in place.

It might be well to say right here that the valve seat (D), **Fig. 6**, is usually narrower than the seat of the valve, so that if there is any grooving to be found it is almost certain to be exclusively confined to the valve as shown.

To remove these ridges seems difficult but they can be carefully filed off by holding the valve head in the fingers as shown in **Fig. 7** and then taking a short hold on a fine file, holding it at the proper angle, and

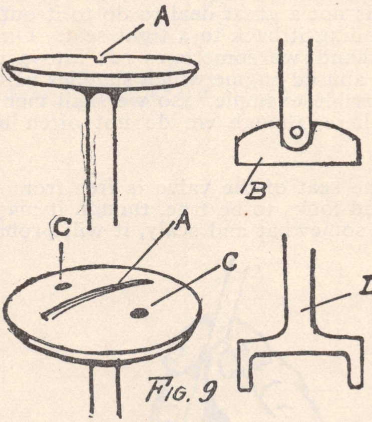


Fig. 9

with very short strokes work round and round the valve seat, taking only a little off at a time until the ridges are brought down to the level of the surface (A), **Fig. 6**, great care being taken not to file away any of the surface (A) during this operation.

Having got a uniform surface on the seat of your valve, the next step is to pass the tip of the finger over the surface of the valve seat (D), **Fig. 6.** If the surface of this seat feels smooth and free from grit, we are now ready to commence the actual valve grinding.

We might say that the mechanic, as a last test, always passes his finger over all surfaces which he desires to have clean. No rag or waste, no matter how clean, can take the place of passing the finger over a surface, because any grit or dirt is instantly detected.

Applying Clover. Now apply a very small quantity of Clover Grinding Compound to the seat of the valve with the tip of the finger as shown in **Fig. 8.** You only require a trifling amount, but it must be smeared on evenly all over the seat.

For the roughing, or first operation, use the **coarse** grade in the Clover Duplex can, or for garages or the shop where pound cans are used, we recommend Grade D Clover Compound, as it cuts exceedingly fast. The valve is now dropped gently back into place and a grinding tool which fits

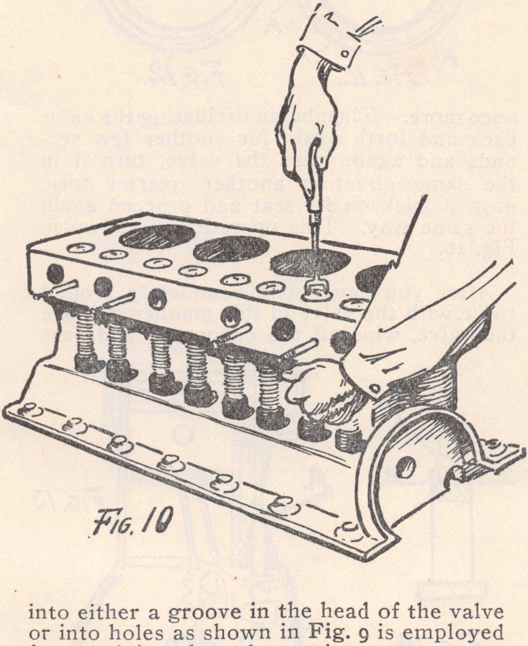


Fig. 10

into either a groove in the head of the valve or into holes as shown in **Fig. 9** is employed for revolving the valve on its seat.

In case the valve head is slotted as shown at (A), **Fig. 9,** an ordinary large size screw driver can be used just as well as anything else, the tool (B) being in reality simply an equivalent of a screwdriver for this special purpose.

Where holes are employed as shown at (C), **Fig. 9,** as in the Ford valves, a special tool shown at (D) is required. Most valve heads, however, are slotted.

Grinding the Valve. Now take your valve tool or screw driver and bear down on the valve with a slight pressure and oscillate the valve back and forth on its seat for a few seconds. Then, with your free hand, reach under the valve stem, push the valve up and off its seat, revolve it a quarter turn and let it fall back on its seat

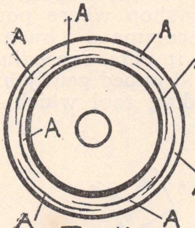


Fig. 11.

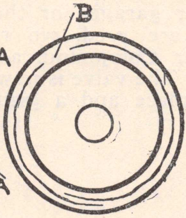


Fig. 12.

once more. Then begin oscillating the valve back and forth again for another few seconds and again raise the valve, turn it in the same direction another quarter turn, drop it back on its seat and proceed again the same way. This operation is shown in Fig. 10.

After you have gone completely around twice with the valve in this manner, remove the valve, wipe off the compound and pass

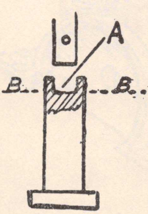


Fig. 14

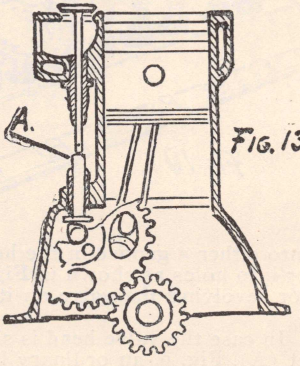


Fig. 13

the finger over the seat to make sure it is clean. Then carefully wipe the compound off the valve seat, and pass the finger over this seat also.

Examine the two seats carefully and see if they seem to be ground evenly all over. If not, repeat the operation, using again the "coarse" grade of Clover Compound.

When you believe that you have a uniform looking seat, clean both seats carefully and apply a small quantity of "fine" grade Clover Grinding Compound (Grade A) and once again go through the same operations, only using the fine "Grade A" instead of the coarse grade.

Caution:—The usual mistake which is made, is to carry the grinding operation too far. The average valve requires but little grinding to make it tight, but it should have this little grinding often, say every 2,000 miles.

After you are through with your two grinding operations—the "roughing and finishing," as it is called, clean all surfaces

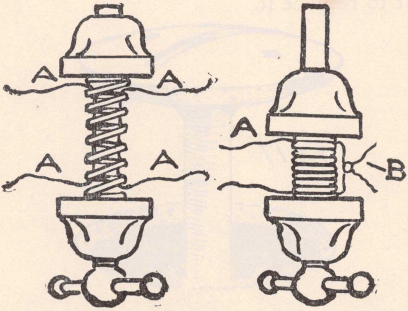


FIG. 15 FIG. 16

with the greatest care, and then apply a thin film of clean oil to the seat of the valve and drop it back into place once more.

This time apply all the pressure you can to your valve tool and oscillate the valve a number of times in its several positions, just as if you were grinding it, only with oil instead of compound, and using more pressure.

Now take the valve out, wipe off the oil carefully and get a reflected light on the surface of the seat of the valve, by holding it at the proper angle between your eye and the light.

Turn the valve slowly, keeping your eye fixed at the same point of reflected light and you will see some fine, very bright or polished lines, which run around the seat. These lines represent the points of contact.

Are the Valves Tight? Refer now to **Fig. 11** and you will note that these bright lines (A) are not necessarily continuous all around the seat. One line will run part way around and then stop, and another will then start, go further along and run out and so on; usually not so short as these shown, but rarely a continuous line. If all these lines **overlap** as shown in **Fig. 11,** the valve is tight on its seat, but if they fail to overlap as shown at (B), **Fig. 12,** then there will be a leak at (B), and it is necessary to commence all over again and grind the valve some more, beginning with the coarse compound and finishing with the fine, then testing its tightness by rubbing in with oil as before.

When the valve is found to be tight, **we** want to replace it.

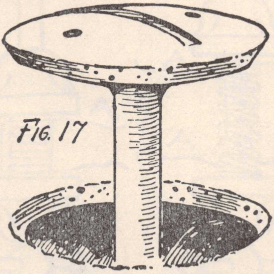


Fig. 17

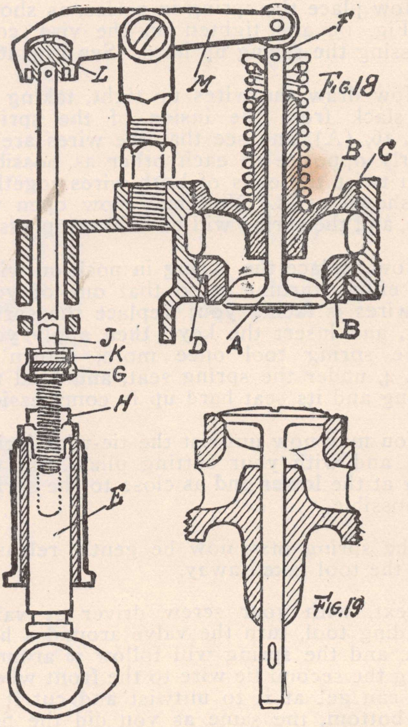
First, make another careful **examination** of the relation **now existing** between the end of the valve stem and the push rod, as this relationship has been changed, due to the grinding. You must still have clearance, however, between the valve stem and the push rod. See **Fig. 5.**

Replacing the Spring. We must now replace the spring before we make the adjustment of the push rod, as the spring will hold the valve down much tighter than you could hold it, and any adjustment made before the spring is in place would be found to be incorrect.

While we are on the subject of adjusting the clearance between the valve stem and push rod, please refer to **Fig. 13,** which shows a section through a Ford cylinder and valve gear. You will note, by referring to (A), that there is no adjustment provided on the push rod, as in other engines illustrated in **Fig. 5,** (A-B), and therefore, **we** have to handle it differently.

Usually, you will find in old engines of this type, that the valve stem has worn a cup in the end of the push rod, as shown in **Fig. 14**, (A). In such cases, you must file this cup off, leaving the top of the push rod flat at the line (B-B).

This will leave too much clearance between your valve stem and the push rod which can be remedied in one of three ways:



(1) Buy a new valve, the stem of which is left long, and which you can file off to give the required clearance, as described later; (2) Buy a new push rod, and adjust by filing the valve stem; (3) Apply a little device which may be bought of any Automotive Equipment dealer, which snaps on the end of the push rod and fills the gap between the valve stem and push rod. This little device consists of a sort of a cup which fits down over the push rod, and the desired clearance is obtained by adding thin metal discs under it, which it holds in place.

We are now ready to replace the spring—usually found to be a very difficult job, but in reality very easy if you do it this way.

Cut two pieces of thin soft wire, each about 6 inches long. String these through the valve spring as shown in **Fig. 15,** (A-A). The ends of the wires should project through the first coil of the spring on either end and be opposite to each other.

Now place the spring in a vise, as shown in Fig. 15, and tighten up the vise, compressing the spring up hard. See **Fig. 16.**

Now draw the wires up tight, taking up all slack from the inside of the spring, **Fig. 16,** (A), and see that the wires are as nearly opposite to each other as possible, then twist the ends of both wires together as shown at B. You may now open the vise, and the spring will be held compressed.

Now replace the spring in position without effort, turning it so that one of your tie-wires is facing you; replace the spring seat, and insert the key; then apply your valve spring tool once more, shown in Fig. 4, under the spring seat, and hold the spring and its seat hard up in compression.

You may now untwist the tie-wire facing you, and with your cutting pliers, cut the wire at the **lower end** as close to the spring as possible.

The spring may now be gently released and the tool taken away.

Next, with your screw driver or valve grinding tool, turn the valve around a half turn, and the spring will follow it around; bring the second tie wire to the front where you can get at it to untwist and cut it at the **bottom,** the same as you did the first one. With your pliers, you can get hold of the upper ends of the tie-wires and pull them out easily.

The engine should now be turned over by hand to see that the valve operates freely and comes down properly on its seat, stopping when the push rod is **completely down, and free from the valve stem.**

Clearance: Push Rod and Valve Stem. We must now adjust for clearance between the push rod and valve stem, which is done by loosen-

ing off the lock nut (A), **Fig. 5,** and screwing the bolt (B) up or down as desired, to arrive at the proper clearance.

When proper clearance has been obtained, hold the bolt (B) firmly in position with a wrench, and tighten the lock nut (A) down hard, being careful that the bolt (B) does not move in this locking operation.

The proper clearance may be found by slipping a visiting card, or a piece of very thin cardboard between the valve stem and push rod, which card should only pass through with some friction.

In the case of the Ford valve gear and others like it, where no adjustment is provided, proceed as outlined in a previous paragraph, until you obtain the desired clearance.

Where a valve is found to be badly pitted, as shown in **Fig. 17,** the usual mistake made by both laymen and professional is to attempt to grind out all of the pits.

This is not necessary, so long as you can obtain a good line of contact between the pits, as is nearly always the case. The mere fact that the pits are there does not harm, provided that you have a good contact, as shown in **Fig. 11.** If one of the pits should cut through this contact line, of course you will have a leak at that point; otherwise not, and the least amount of grinding you are compelled to do, the better—as over-grinding simply cuts your valve and the valve seat for nothing. We again repeat, grind a little, but often.

Valve-in-Head Motor. We have not yet touched on the valve-in-the-head motor, in which the actual process of valve grinding is the same as described above, the arrangement of parts being different.

We refer you to **Fig. 18,** which represents a usual type of this construction. The valve (A) is carried in the cage (B-B); which cage either screws into the cylinder head as shown at C, or is clamped into place, and which has a gas-tight joint at D, this joint being either a ground joint, or made tight with a copper gasket.

This cage (B) may be removed, and with it the valve, valve spring, etc. See **Fig. 19.**

The valve, spring, valve seat, and key are the same as described elsewhere.

The clearance between the push rod (E) and the valve stem (F), however, is arrived at somewhat differently.

The push rod (E) has an adjustment nut (G), and its lock nut (H), the same as described, only the rod (J) is secured by a flexible joint (K) to the push rod, and by another flexible joint (L) at its other end, which connects it to the tappet or rocker arm (M).

Thus, it will be seen that the push rod (E) and the rocker arm (M) work as a unit.

The clearance, therefore, between the end of the valve stem (F) and the push rod is actually measured, in this case, between the valve stem and the rocker arm at (F), while the adjustment is made at (K), the same as previously described.

To Determine Whether you Have Leaky Valves or a Leak Past the Piston. See that all the pet cocks on the cylinder head are closed (if your engine has them), then mix up some soap suds and, with a brush or a rag, apply the suds around each cylinder head plug, each pet cock, and each spark plug where it screws into the cylinder, and also around the porcelains.

Turn the engine over slowly with the crank, bringing it up to compression on one of the cylinders, and hold it there for a few moments in one position. If the pressure on the crank begins to slacken, you know at once that there is a leak in compression in this cylinder somewhere. Find out which cylinder it is and remember it; then force over this compression to the next, and try each cylinder in turn in the same way.

As you are turning over and creating compression in first one cylinder, then another, examine carefully all points where you have applied the soap suds, and if you see soap bubbles forming, you can easily spot the leak and remedy it, which should be done before proceeding further.

All of the spark plugs, pet cocks and cylinder head plugs being tight, have some one turn the engine over for you, hold on each compression point as before and while this

is being done, place your ear close to the breathing tube in the crank case through which oil is usually inserted in the motor, and listen carefully for a hissing sound. If you can't get your ear down to the breathing tube, you can take a short length of garden hose, holding one end to your ear and the other to the tube, and you can hear just as well.

If there is no hiss in the base, and you are losing compression, it is a leaky valve. If you do get a hiss, you know that you have a leak past your piston, which should be remedied; but you may have a leaky valve also, though the only way to find it out in such a case, is to remove the valves of this cylinder and examine them.

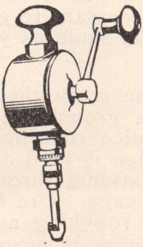
If you are able to hold against the compression of a cylinder for half a minute without perceptible loss of compression, let it alone, as it is good enough.

Should you find a leak past a piston, you should give it prompt attention, as leaks of this character develop rapidly and often injure the cylinder beyond repair.

Hand Power Valve Grinders.

We illustrate below a form of hand power Valve Grinding tool which has merit. There are many such tools on the market, some better than others, which find use in private garages where there are several cars to take care of, and also in small public garages.

We recommend that no spring be placed under the valve when the hand power tool is used, and that the same grades of Clover Compound be used and that the same procedure outlined on page 9 given for hand grinding be followed.



Electric Valve Grinders.

We have described so far only hand grinding of valves, using a screw driver or other similar tool for the purpose.

There have been developed Electric Valve Grinding tools of high efficiency which give an oscillating movement to the valve and at the same time shift the position of the valve during the operation of grinding.

For garages or in manufacturing plants where there is a lot of valve grinding to be done, such tools are of great value.

Due to the rapid working of these electric tools it will be found desirable to use a finer grade of compound for roughing than where the work is done by hand, and we recommend our grade B Clover Compound for the roughing operation and the A grade Clover Compound for finishing.

As a matter of fact, if but little grinding is necessary, you can often do the entire job with the A grade.

With an electric tool it is also found desirable to place a spring under the valve while grinding. This spring tends to relieve some of the weight of the electric tool.

Grinding in Valve Cages on Valve-in-the-Head Motors.

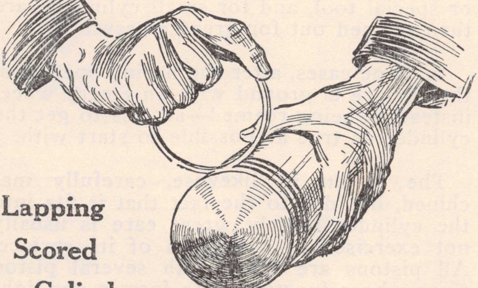
On page 13 we give a cross-section of a usual design of valve-in-the-head construction; and it will be noticed that the valve-cage is kept down tight on its seat "D", by means of the screw-thread, "C"; and that in order to secure a gas-tight joint at "D", a copper gasket is used.

Another popular construction provides for a ground joint at "D", instead of using a gasket; and when this construction is adopted, it is necessary to grind a gas-tight joint at "D", the same as you would grind a valve.

Of course, the screw-thread, "C", cannot be used with a ground joint at "D"; and so instead, a nice running fit is made at "C" and the cage is held down on its seat by two bolts passing through a flange on the top of the cage. Use Grade D Clover Compound for roughing and Grade A for finishing.

COMPRESSION LEAKS

Bulletin No. 80



Lapping
Scored
Cylinders,
Lapping in Piston Rings,
Fitting Rings To Pistons

A FEW words regarding the physical properties of the materials we have to deal with and the causes for cylinder scoring or scratching may be found useful, and we shall treat them briefly.

Cylinders are generally made of close grain, soft, cast iron. The cylinder is first bored as true as possible with a boring bar or special tool, and for small cylinders, are then reamed out for greater accuracy.

In some cases, after the boring operation, the surface is ground with an emery wheel instead of being reamed—all this to get the cylinder as true as possible to start with.

The piston is, likewise, carefully machined, but due to the fact that it fits into the cylinder loosely, great care is usually not exercised in the finish of its surface. All pistons are fitted with several piston rings whose function is to form a gas-tight sliding contact joint between the piston and the cylinder walls.

Piston Rings. Piston rings are so made that they expand with pressure against the cylinder walls, and it is manifest, therefore, that when they are out of the cylinders, they have a larger diameter than the cylinder for which they are intended, and therefore, must be compressed or squeezed together in order to get them in. When they are in, they exert a considerable pressure against the walls of the cylinder.

It will also be seen that when the ring is out of the cylinder it cannot be round, for it is necessary that it should be exactly round only when it is compressed to the size of the cylinder for which it was made.

Right here we may pause to impress the importance of using a piston ring which is **exactly round when it is compressed to the size of its cylinder.**

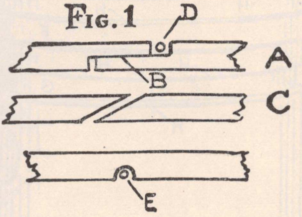
All piston rings are split on one side, in order to allow them to spring. The two old-fashioned methods of splitting rings are illustrated in **Fig. 1.**

By referring to **Fig. 1** (A) it will be seen that the ring is split by one horizontal and two vertical cuts. The contact surfaces at

(B) are carefully scraped and ground gas-tight. If well made, this form of construction is thoroughly satisfactory and can be made to give a gas-tight job.

The oblique slit shown in **Fig. 1 (C) is** rather easier to make, and costing less to produce, is found usually in the less expensive engines. It is difficult with this style of ring to get a thoroughly gas-tight job.

With either of the constructions shown, it is important that the slits in the several rings on the piston should be prevented from lining up vertically, and to prevent this, pins are often placed in the ring grooves, which in the case of style (A), lodge in the space (D) which has been provided; or for style (C) ring, there is usually a notch cut on the back of the ring



as shown at (E). These pins allow the rings full freedom except that of turning in their groove.

You will find advertised a dozen special styles of piston rings with elaborate claims as to what they will do for your motor by way of holding compression—some of these special design rings have merit—others have less—**but the only thing that any special ring can do for us is to insure a good gas-tight joint at the slit in the ring proper, which is represented by the surfaces (B), Fig. 1 (A).**

Please refer to **Fig. 2.** You will note the two rings (A) and (F) in place. The slit in ring (A) is turned to the front where it is seen but the slit in the ring (F) can not be seen as it is pinned 120 degrees apart.

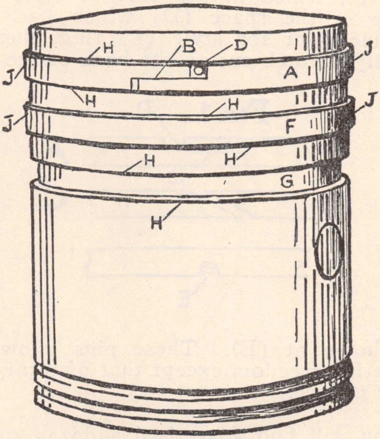
The third ring is not in place, but the groove (G) is shown ready to receive it.

If you will examine the drawing carefully, you will see that while it is absolutely

necessary to have a gas-tight joint at (B), **that it is also just as necessary to have a gas-tight joint between the rings and the cylinder on the surfaces (J), (J), also on the surfaces of contact between the rings and the sides of their grooves, (H), (H), (H), (H).**

All rings, therefore, whether they are of the garden variety shown in **Fig. 1**, or special styles, **must in each case** be fitted **to** their grooves, and (2) fitted into the cylinder in which they work; if not fitted, the most expensive rings you can buy, with big

FIG. 2



claims of efficiency, will serve you no better than the ordinary.

The Cylinder. **Let us get back for a moment to the cylinder.** We stated that cylinders were made as a rule of very soft cast iron. The question at once arises, is there not a lot of wear due to the friction of the rings on the cylinder walls? The answer is no.

Cast iron has many wonderful properties and among them is its ability to become glazed or case hardened when rubbed with other metal while lubricated.

All cast iron cylinders in which a piston works, whether used for a gas, steam, oil engine or air compressor, become glazed

in time, due to the friction of the piston rings on its surface, assuming always that there is proper lubrication.

This glazing or case hardening is exceedingly hard—so hard in fact that it is practically impossible to cut it with any ordinary tool.

When your engine is new, therefore, the walls of the cylinders are very soft, and the contact surfaces of the piston rings are also soft, and it is through use that these surfaces gradually become glazed or hardened.

You will readily appreciate how much care should be exercised at first with a new engine until the cylinders and piston rings get their glaze, and that lots of oil should always be used at first—in fact, a film of light blue smoke should always be coming from your exhaust for the first few weeks—your motor should never become overheated—never forced—in short, a new engine should be babied along for a few weeks at first to allow this glazing operation to take place, and then it can gradually be given some work. Many a good engine is ruined for lack of first care, as suggested above.

Cause of Score Marks. Assuming that you have brought your engine through the critical period and that its cylinders and piston rings are nicely glazed, **there are only three things which will score, or produce a scratch on the cylinder walls:** (1) lack of oil; (2) an overheated cylinder; (3) leaky piston rings.

Now, outside of the loss of compression resulting from such scorings, and consequent loss of power, there is a more dangerous condition to be considered, as these scores allow the white hot gases after explosion in the compression space to escape at high pressure between the rings and the cylinder walls, and being enormously hot, burn away the oil at these points and also burn the metal of both the rings and the cylinder. Thus, when a leak of this kind starts, it gets rapidly worse, and if allowed to exist any length of time, will seriously injure both rings and cylinder.

A **leaky or bad fitting piston** ring will give the same results as the score marks

described above, as it, also, allows the hot gases to pass.

Pumping of oil from the base past the piston into the compression chamber is also one result of a leak past the piston—a tight piston will not pump oil.

When a cylinder is bored out for the first time, the skin, or hard metal surface which lies next to the core sand in casting, has to be cut away to reach the soft metal which lies under it. The cylinder is then bored true, and if heat were not applied to it, it would stay true.

However, our cylinder must work in intense heat, and as soon as this heat is applied, the cylinder begins to twist and warp in all kinds of shapes. It simply won't stay round.

In the early days of gas engine construction, the first skin was taken out and the cylinder was then heated to cherry red in a gas oven and allowed to cool slowly. This tended to warp the cylinder badly, which was just what was wanted, as it was then replaced in the boring mill, and bored true, and this time it remained true, or nearly so.

In the present-day rush, and the desire to cheapen all operations, this preliminary heating process is resorted to only by manufacturers of some of the best and more expensive motors.

We then, must consider that in most motors the cylinders will be found to be out of round—by a trifling amount to be sure, but it doesn't take much to cause trouble.

Likewise, many of the piston rings which are sold have not been pre-heated after they were roughed out of the casting, and before they are finished, with the result that as soon as they do get heated in the cylinder, they too warp out of round.

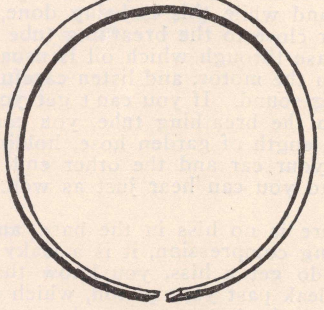
This tendency to warping in a new cylinder and with new rings, accounts for many leaks past the piston, **and the remedy is found in lapping out the cylinders true, then lapping the rings back in place,** as described later.

Piston rings should be so designed as to give an equal pressure, as they expand at all points of the cylinder walls. The old-fashioned way to accomplish this was to make the ring thicker on the side opposite the slit. By careful design with this method, it is possible to get an equal pressure at all points—a feature of the highest importance. **See Fig. 3.**

In selecting a piston ring, you should assure yourself that this equal pressure feature has been taken care of, otherwise you may look for bad results.

We have given you accurate and undisputed facts, the reasonableness of which

FIG. 3



we believe will appeal to you, and we believe you will agree with us when we state that no piston with new rings, regardless of what these rings may be, will give a tight job without first lapping or grinding them into piston grooves and then into the cylinder in which they are to work.

Determining Leaks. **To determine whether you have leaky valves or a leak past the piston:** see that all the pet cocks on the cylinder head are closed (if your engine has them), then mix up some soap suds and, with a brush or rag, apply the suds around each cylinder head plug, each pet cock, and each spark plug where it screws into the cylinder, and also around the porcelains, also around all gaskets.

Turn the engine over slowly with the crank, bringing it up to compression on one

of the cylinders, and hold it there for a few moments in one position. If the pressure on the crank begins to slacken, you know at once that there is a leak in compression in this cylinder somewhere. Find out which cylinder it is and remember it; then force over this compression to the next, and try each cylinder in turn in the same way.

As you are turning over and creating compression in first one cylinder, then in another, examine carefully all points where you have applied the soap suds, and if you see soap bubbles forming, you can easily spot the leak and remedy it, **which should be done before proceeding further.**

All of the spark plugs, pet cocks and cylinder head plugs and gaskets being tight, have someone turn the engine over for you, hold on each compression point as before and while this is being done, place your ear close to the breathing tube in the crank case through which oil is usually inserted in the motor, and listen carefully for a hissing sound. If you can't get your ear down to the breathing tube, you can take a short length of garden hose, holding one end to your ear and the other end to the tube, and you can hear just as well.

If there is no hiss in the base, and you are losing compression, it is a leaky valve. If you do get a hiss, you know that you have a leak past your piston, which should be remedied; but you may have a leaky valve also, though the only way to find it out in such a case, is to remove the valves of this cylinder and examine them.

If you are able to hold against the compression of a cylinder for half a minute without perceptible loss of compression, let it alone, as it is good enough.

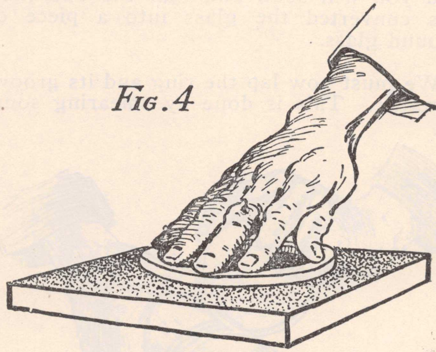
If you decide you have a leaky valve send for the Clover Bulletin No. 75, a complete treatise on valve grinding.

Fitting Rings to a Piston. First make sure that the ring to be fitted is the right size for your cylinder. If you are a mechanic with the proper tools and gauges at hand, you can very easily compress the ring to the cylinder size and check it up for accuracy. If, however, you have not these conveniences or the neces-

sary knowledge for this operation, you can get a very good idea as to whether the ring is about right or not, by crowding it into the end of the cylinder and examining carefully its contact with the walls of the cylinder. As far as you will be able to determine, **it should seem to touch perfectly all around.** If it fails in this, don't bother with it, get another.

Now examine the groove in which the ring is to work. See that its edges are sharp, and its sides are square.

FIG. 4



Next, lay the piston down on a clean bench or on a piece of paper, and try the ring in its groove. It should fit **very tight** or better yet, it should be too wide to get in at all.

You must then begin to lap the ring down so that it will enter its groove, but it must be such a close fit that there is no perceptible play.

This lapping is done by rubbing the ring on a perfectly flat plate of metal, using **Grade A Clover Grinding and Lapping Compound** as shown in Fig. 4. You should use a rotary motion, working all over the surface of the plate, and every little while, turning the ring around into a different position.

It is also advisable to lap both sides of the ring, rather than to take off all the metal from one side.

Every little while, depending on the amount of metal to be removed, you should

clean the ring, and try it in its groove by rolling the piston and the ring together as shown in **Fig. 5.** As soon as the ring can be **crowded tightly** to the bottom of the groove, your job is complete.

Should you not have a surface plate, or smooth, accurately surfaced piece of metal on which to lap your ring, a piece of glass, preferably plate glass, will do equally as well.

Smear the Clover Compound on the glass evenly and begin working the ring over it, and you will soon find that the operation has converted the glass into a piece of ground glass.

We must now lap the ring and its groove together. This is done by smearing some

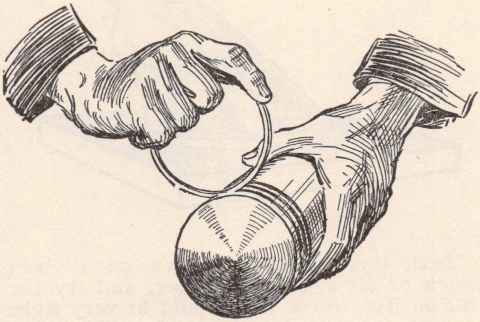


FIG. 5

Grade 1-A or A Clover Grinding and Lapping Compound on the ring and rolling the ring in its groove round and round as shown in **Fig. 5.**

Caution: Be very careful in this operation, as it takes very little of this kind of lapping—so go slow—clean the ring and its groove often and try for fit.

As soon as the ring fits the groove easily, **and will roll in the groove by its own weight, but without** any side shake or looseness, your ring is fitted and may be sprung into its place.

In springing rings onto the piston, expand them only what is absolutely necessary to get them on. It is very easy to injure or break a ring while springing it in place.

Lapping Rings into a Cylinder. After your rings are carefully fitted to the piston as above described, your next work is to lap them into the cylinder in which they are to work.

Dismount your cylinder and lay it on a bench with the bottom facing you. See Fig. 6. If the cylinder has a removable head, take it off. Clamp the cylinder to the bench, or if it is small, it sometimes may be held in a vise.

If the cylinders are large they may be lapped in place without removing from the engine base, as with marine and stationary engines.

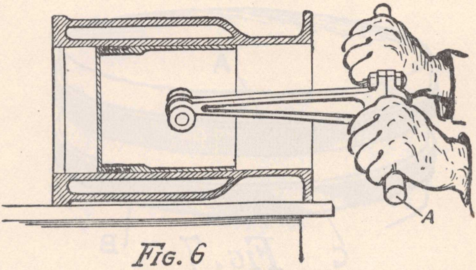


FIG. 6

In the shop, the cylinder may be placed on the drill press table and lapped by power, working lap up and down as it rotates.

You should now take your piston with all rings mounted, and the connecting rod in place, and **first carefully plug up all oil holes in the piston pin** by poking in some waste, or you may use a wooden plug, making sure that it can easily be removed.

Next fit a piece of wood, (A) **Fig. 6, into** the crank pin end of the connecting rod as shown, to use as a handle, and clamp in place.

Take some **1-A Clover Grinding and Lapping Compound** for a small cylinder, or **Grade (A)** for a large one, and with the palm of the hand, smear a thin, uniform coating over the walls of the cylinder.

Now take a little ordinary machine oil in the palm of your hand and rub over the piston.

You may now insert the piston and begin working it back and forth **the entire length of the cylinder,** giving it a one-eighth turn every second stroke.

After you have got all the way around, and made sixteen strokes, remove the piston, and carefully wash off all the grinding compound with some kerosene, **being careful not to get the slightest particle of the compound on the wrist pin and its connecting rod bearing.**

The best way to remove the compound is to lower the piston, head down, into several inches of kerosene and work the

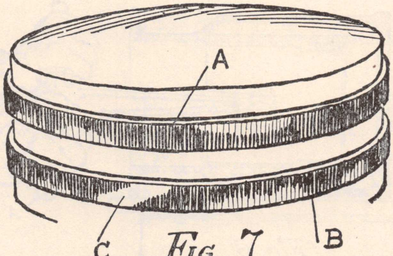


FIG. 7

rings around with the fingers until all the abrasive is freed. Next you must wipe the compound out of the cylinder with a rag, then wash out the cylinder with kerosene thoroughly. The last thing you must do after you believe all parts to be clean, is to pass the hand over all surfaces, and if any abrasive remains, it will be quickly detected.

Testing the Fit. To test the fit, take some Prussian Blue (or thinned out red or white lead), which may be bought at all hardware and automobile stores, and smear a very thin, but uniform layer all over the inside walls of your cylinder. Insert the piston with rings in place once more, and work it back and forth two or three times, turning it a quarter of a turn at the end of each stroke.

Remove the piston, and examine the contact surface of each of the rings. The entire circumference of each ring should show traces of blue.

If you find that there are voids, or spots on the ring on which there is no blue, and these voids extend the entire width of the ring, you may be sure the ring is not tight, and you must repeat the lapping operation.

Fig. 7 (A) shows the appearance of the contact surface of a tight ring, while (B) shows a ring with void at (C) where it does not come in contact with the cylinder walls and where a leak will occur.

When you have finally got tight rings, **remove the plug which you placed in the piston pin oil hole, and use the greatest care in seeing that no abrasive** remains around the hole, as it would get into your piston pin bearing and ruin it.

Removing Score Marks from Cylinders. When you discover that your cylinder is scored, the natural thing to do is to consult an auto supply catalog, or talk the matter over with someone who is likely to advise you to have your cylinder re-bored and fitted with over-size pistons and rings.

The fact is that 999 cases out of a 1000, if taken care of when first noticed, can be cured by simply lapping out the score marks, and then lapping in your old rings, mounted on your old piston.

In other words, the vast majority of cylinder score marks are not over 1-1000 to 2-1000 of an inch deep, and enlarging the cylinder by such a trifling amount as is necessary to remove them will not affect the proper working of your present piston and rings, when they are properly re-fitted to the repaired cylinder. **AT LEAST TRY LAPPING OUT THE SCORE MARKS IN EVERY CASE** before you submit to having your cylinder re-bored.

The process of lapping a cylinder is, in itself, simple, but there are several things which must not be overlooked, as they will affect the result.

How to make a Lap. One of the best things you can use for a lap is an old cast iron piston, of your cylinder size, which you can cut in two with a hack saw between the piston pin bosses as shown in **Fig. 8**—(A).

Next get a piece of flat iron (E) of sufficient length and say ¼ inch thick, and wide enough to receive a hole (B) just large enough to allow the piston pin to pass through.

Insert the piston pin in one-half of the piston, and fix it with the set screw (C). Then make two springs (D), (D), to fit on either side of the iron piece (E) as shown, bearing on the two bosses, and

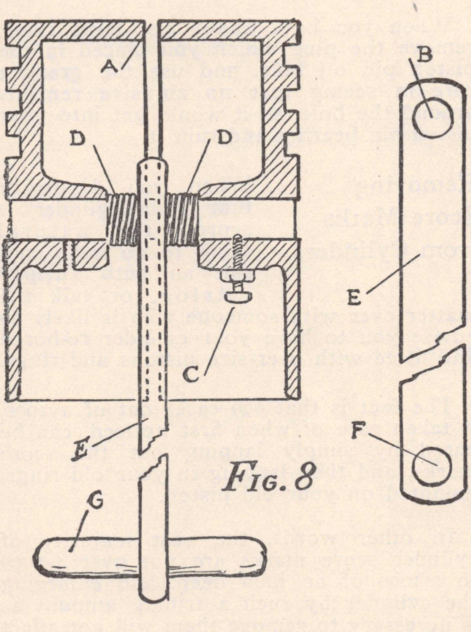


FIG. 8

tending to separate the two parts of the cut piston.

Now slip the other half of the piston onto the pin, **but do not hold it on this side with a set screw;** allow it to slide freely on the piston pin. You can bore a hole (F) in the other end of the iron piece (E), and drive a piece of hard wood (G) into it for use as a handle.

Should it be impossible to obtain an old piston with which to make a lap, you can get excellent results by having a piece of hard wood turned on a lathe to your exact cylinder size, the length of the piece being the same as the length of your piston. **Fig. 9.**

Bore a hole (A), (B), in the center, and clean through the block. This hole should be of a size to permit of a driving fit for a pin, which can be of a piece of bar iron or a piece of ½ inch pipe.

Next saw a ¾ inch section vertically out of the block (C), (C), (C).

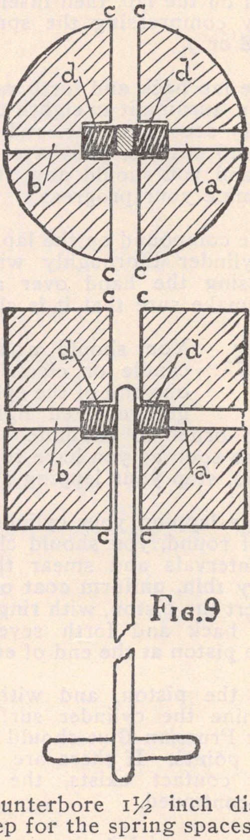


FIG. 9

Now counterbore 1½ inch diameter by ¾ inch deep for the spring spaces (D), (D).

Drive your pin into the hole on the side (A). With a round file, enlarge the hole on the side (B) so that it slides easily on the pin.

Make up springs and a handle as described for the piston above, and assemble as shown in the cut.

Your lap being complete, proceed to lap out your cylinder as follows:

Secure your cylinder to the bench as shown in **Figs. 6 and 11**, or in a vise as previously suggested; then smear the cylinder walls with an even coating of **Grade (A) Clover Grinding Compound, or Grade (1-A)** for close work.

With your hand, wipe a small amount of machine oil on the lap, then insert it in the cylinder by compressing the springs (D), (D), **Figs. 8 or 9.**

Work the lap back and forth with a slow even motion, turning it an eighth turn at the end of every second stroke, and when you have made 16 strokes, you have completed the circle and you should now remove the lap to examine your progress.

Leave the compound on the lap, but clean out the cylinder thoroughly with a rag, finally passing the hand over all of the surface to make sure that it is clean.

Examining for Fit. You should now hold a candle or electric light at one end of the cylinder, and get reflected light on the surfaces in order to examine them carefully, and as soon as you have removed the score marks, stop your lapping at once.

If you are lapping your cylinder because it is out of round, you should clean it out at short intervals and smear the surface with a **very thin, uniform coat** of Prussian Blue. Insert the piston, with rings in place, and work back and forth several times, turning the piston at the end of each stroke.

Remove the piston, and with reflected light examine the cylinder surfaces carefully. The Prussian Blue should show contact at all points. If there are any voids, where no contact exists, the operation should be continued.

Right here we wish to impress upon you the importance of using **Clover Grinding and Lapping Compound** in preference to anything else for cylinder lapping, as you will readily appreciate that the entire **success of this operation depends on the degree of uniformity which the abrasive compound can be made to maintain during the process of lapping.** If the grease binder, due to heat of friction from rubbing, melts even the slightest bit and lets go some of the abrasive which it holds in mechanical

mixture, this abrasive will flow to one side and concentrate, and you will find that your cylinder has been lapped out elliptical instead of round. The patent formula of Clover Grinding and Lapping Compound absolutely prevents such danger, and it is the only lapping material in the world which can be absolutely relied on for such a delicate operation.

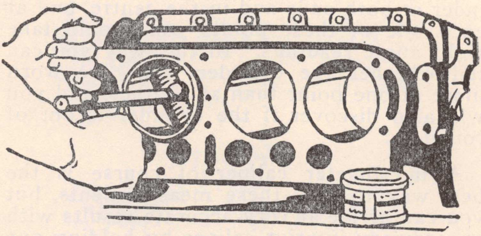


FIG. 11

Cylinder Lapping with a Press.

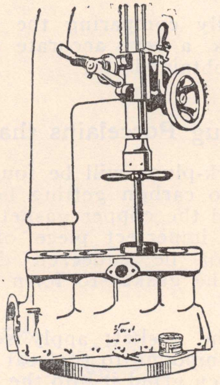


FIG. 12

Cylinder. Lapping With a Drill Press. The Cylinder Lapping Tool may be provided with a lug on the handle bar which is accurately machined to ½″ and which will fit into any chuck of this size.

By referring to **Fig. 12** you will note that the cylinder block has been removed and placed on the table of the drill press; the lapping pads inserted into one of the cylinders, and the lug on the handle bar secured in the chuck.

Care should be used to make sure that the surface of the cylinder block resting on the drill press table is clean and free from projections. Sometimes the babbit from the bearings projects above the surface line of the flanges and this would throw the cylinder block out of line.

Before proceeding further, you should carefully measure the diameter of your cylinder at both ends and in the centre, and at each one of these points you should take right angle readings. In this way you can tell whether the cylinder walls are worn more at one point than at another, and you will also discover if the cylinder is out of round.

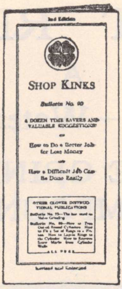
A micrometer caliper of course is the best way to take these measurements, but you can arrive at very accurate results with an ordinary interior caliper by holding one arm of the caliper firm to one side of the cylinder and rocking the other arm of the caliper back and forth against the opposite wall.

By carefully comparing the amount of possible rock, a very accurate approximation can be obtained.

Spark Plug Porcelains that Leak.

Often spark-plugs will be found to leak, due either to carbon getting between the porcelain and the copper gasket, or due to a rough or imperfect piece of porcelain which cannot be squeezed down tight enough on the gasket to form a gas-tight joint.

Remove the gasket; apply some Grade D Clover Compound to the seat part of the porcelain; then grind it into the metal body of the plug. When ground true and smooth, clean thoroughly and assemble once more with the gasket in place.



Shop Kinks.

WE publish a very interesting little book that contains a great many valuable shop kinks where a grinding, polishing, or lapping compound is used.

There are so many subjects covered in Shop Kinks that it would be impossible to mention them all except by sending the book itself; but we might refer to several operations that are especially interesting to the shop man, as follows:

How to lap a crank-shaft into its bearings
How a crank-shaft should be trued and lapped
How to enlarge the hole in a bushing
How to reduce the outside of a bushing
Running together gearing
Relieving taps and dies
How to make a feeler gauge
How to correct worn timers
How to fit wheels to axles
How to remove flat spots on shafts

Shop Kinks is profusely illustrated and contains a mass of very valuable information of interest to every person who is mechanically inclined—it will be sent absolutely free of charge to any user of Clover Compound who will write for it, giving the name and address of either his Auto Accessory Dealer or his Hardware Dealer.

JUST RITE

A

Hi-Speed—Water Mixed

VALVE GRINDING COMPOUND

A demand has been created for a special Valve Grinding Compound that would cut at tremendously high speed—speed being the principal object, and the fineness of the job being of secondary importance.

The rate of speed at which any compound cuts is dependent upon two things: (1) the coarseness of the abrasive powder used and (2) the amount of powder used to each pound of the binder; whether that binder be a grease or a water-mixed material.

It is mechanically possible to use a highly concentrated grinding mixture for valve grinding, and, at the same time, obtain good results with high speed. It is just as impossible to use a highly concentrated grinding mixture for fine lapping; surfacing; polishing; fitting of parts and general shop use.

Just-Rite is the fastest water-mixed Valve Grinding Compound in the world, and the best—It will do a fine job of valve grinding, using one grade for the entire job.

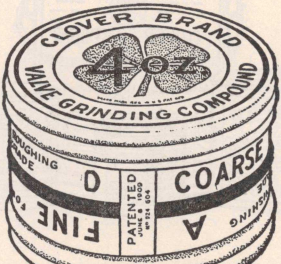
For fine work, however, we recommend the use of two grades of Clover Compound, and Clover should also be used in all other shop operations.

CLOVER

GRINDING and LAPPING COMPOUND

(*Petroleum hard oil base*)

Clover for the Kit



4-Ounce Duplex can, contains two grades: D (Coarse) for roughing and A (Fine) for finishing. This can is fitted with the quick grip covers and is intended to be carried in the kit. The compound in this can is suitable for grinding valves, lapping cylinders, fitting piston rings, and general shop use.

Price .... .50

2-Ounce Duplex can, similar to 4-ounce, only smaller .... .30

The 4 oz. and 2 oz. Duplex cans, ¼ and ½ lb. single grade cans, are put up in separate cartons with a copy of the Clover Dictionary, a little book of directions and suggestions.

CLOVER COMPOUND
FOR
SHOP, GARAGE, AND TOOL ROOM

SINGLE GRADE CANS 8 GRADES

Clover Compound is put up one grade to the can, in ¼-lb., ½-lb., 1-lb. and 5-lb. sizes, in 8 grades as below.

2-A (microscopic fine) For fine lapping, polishing and fitting of parts.
1-A (very fine) For fine lapping, surfacing, fitting of parts, lapping dies, gauges, fine polishing, etc.
A (fine) For finishing valve grinding, lapping cylinders, lapping rings into cylinders, grinding crank shafts into bearings, running together gearing, etc.
B (medium fine) A finishing grade, or on fine work used for roughing.
C (medium coarse) For cylinder lapping, light power grinding, etc.
D (coarse) For rough valves, medium heavy roughing and grinding.
E (very coarse) For use on large surfaces, and for quick work.
50 (special) An exceedingly coarse compound for extra heavy work.

¼ lb. can, any grade	$0.50
½ lb. can, any grade	.85
1 lb. can, any grade	1.50
5 lb. can, any grade	6.00

Samples will be sent gladly or if you are not quite sure which grade to use tell us about your work and we will send samples accordingly.